VELOCITY RESOLVED NIR SPECTROSCOPY OF THE HH34 AND HH46-47 JETS.

R. Garcia Lopez, B. Nisini, T. Giannini, *INAF-Osservatorio Astronomico di Roma, Via Frascati 33, 00040 Monte Porzio Catone , Italy (garcia@mporzio.astro.it)*, J. Eislöffel, *Thüringer Landessternwarte Tautenburg, Sternwarte 5, 07778 Tautenburg, Germany*, F. Bacciotti, L. Podio, *INAF-Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, 50125 Florence, Italy*.

Protostellar jets and accretion discs are phenomena intimately associated. However, the connection between both processes and the jet launching mechanism is still not well understood. Several models have been developed in order to constrain the physical mechanism by which mass is ejected from young stars. Observations of the inner jet structure are required, however, in order to verify the predictions of such kinds of models. In particular, NIR spectroscopy is an important tool to investigate the innermost jet regions. This is especially true for jets in Class 0/I objects, where the high extinction prevents us from observing the inner regions with standard optical tracers. Here, we present some of our results on the HH34 and HH46-47 jets in the region nearest to the driving source. The NIR spectra have been taken with VLT-ISAAC at medium resolution, covering diagnostic lines of the ionised ([FeII]1.64, 1.60 μm) and molecular (H_2 2.12 μm) gas. In particular, the [FeII] 1.64 μm, 1.60 μm lines have been used to derive electron densities and mass flux rates in different velocity components and to understand the connection between the atomic and molecular components.

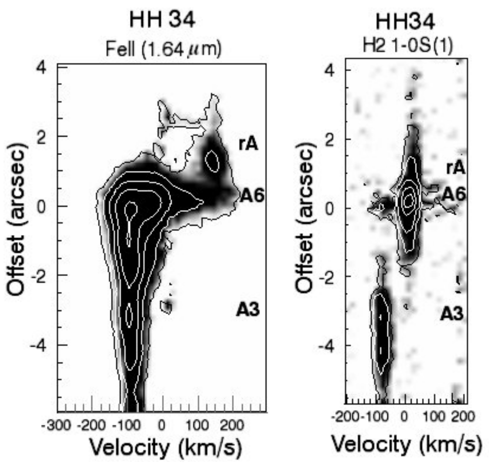

Figure 1: Continuum-subtracted PVD for the [FeII] 1.64μm and H_2 1-0S(1) emission lines along the HH34 jet in the region nearest to the source.

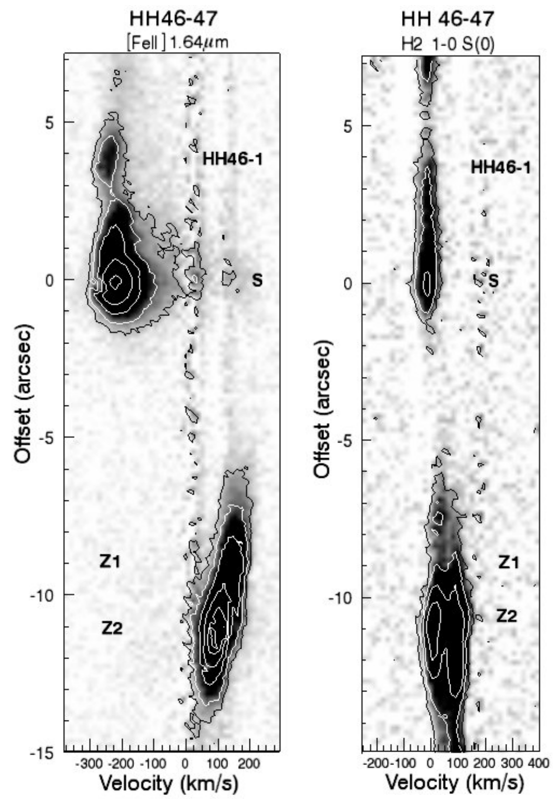

Figure 2: Continuum-subtracted PVD for the [FeII] 1.64μm and H_2 1-0S(1) emission lines along the HH46-47 jet in the region nearest to the source.

Table 1: Electron density and mass flux along the HH34 jet

Knot	n_e (10^3 cm^{-3})	$\dot{M}_{jet}$ ($M_\odot$ yr^{-1})	Comments
A6	10.5	1.6 10^{-9}	HVC
	17	3.4 10^{-10}	LVC
A3	1.8	6.2 10^{-8}	HVC
	2.5	8.6 10^{-9}	LVC
A1	1.8	2.0 10^{-8}	HVC
	2.5	3.4 10^{-9}	LVC

FeII and H_2 Position-Velocity Diagrams (PVDs)

Figures 1 and 2 represent the PVDs of the [FeII] 1.64μm and H_2 2.122μm lines near the central source. Source continuum has been fitted and subtracted in both PVDs. In the X-axis and Y-axis the radial velocity with respect to the local standard of rest and the angular distance from the source are shown. The [FeII] PVDs illustrate the presence of a high and low velocity component, the latter observed only close to the source. In the case of HH 34 our deep [FeII] spectral image

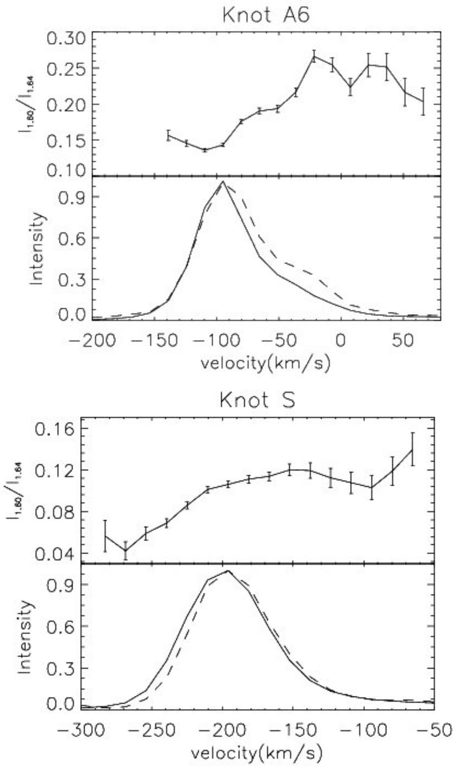

Figure 3: Normalised profiles of the [FeII] lines 1.64μm (solid line) and the 1.60μm (dotted line) and their ratio are plotted for knots A6 (HH34) and S (HH46-47) in the upper and lower panel.

Table 2: Electron density and mass flux along the HH46-47 jet

Knot	n_e (10^3 cm^{-3})	$\dot{M}_{jet}$ ($M_\odot$ yr^{-1})	Comments
S	5.3	2.6 10^{-8}	HVC
	7.0	2.5 10^{-9}	LVC
Z1	2.9	7.3 10^{-8}	HVC
	-	-	LVC
Z2	2.6	3.7 10^{-9}	HVC
	5.1	5.8 10^{-10}	LVC

shows also the redshifted jet, that emerges at a radial velocity of $\sim$130 km/s. The HH34 H_2 PVD also shows two velocity components, at high (HVC) and at low velocities (LVC), but only the low velocity component is observed down to the central source. At intermediate velocities between these two components, no emission is seen in the H_2 PVD. This suggests that the two components may originate from physically distinct regions. A possibility is that the high velocity H_2 is excited at the interface between the atomic jet and ambient medium, while the LVC represents gas excited in oblique shocks along the wall of a wide angle wind cavity. On the contrary, the H_2 HH46-47 PVD only shows a single velocity component near to the source.

Electron density (n_e)

From the ratio [FeII] 1.60μm/1.64μm, the electron density as a function of velocity has been derived adopting the model described in Nisini et al (2002). These lines come from levels with similar excitation energies but different critical densities, thus their ratio is sensitive to the electron density. As an example, Figure 3 shows the normalized profiles of the two lines, for the knots A6 (HH34) and S (HH46-47), and their ratio as a function of velocity. In Tables 1 and 2 (col. 2), the high and low velocity electron densities (n_e(HVC) and n_e(LVC)) are reported. As a first result, it can be noticed that n_e(LVC) is higher than n_e(HVC) in both the jets. Secondly, the value of n_e decreases from the inner to the more distant knots.

Mass ejection flux.

From our spectra, it is also possible to measure the mass flux carried by the HH34 and HH46-47 jets (see col. 3 in tables 1 and 2) for the different velocity components. Using the relation described in Nisini et al. (2005), the high and low velocity mass ejection flux ($\dot{M}_{jet}$(HVC)) and $\dot{M}_{jet}$(LVC)) have been calculated combining the derived electron densities and the luminosities of the [FeII] 1.64μm line. In fact, the [FeII] lines are optically thin, thus their luminosity is proportional to the mass of the emitting gas. In both the jets, we have assumed an ionisation fraction of 1 and a Fe solar abundance of 2.8 10^{-5}. In both the jets, $\dot{M}_{jet}$(HVC) is higher than the $\dot{M}_{jet}$(LVC). More in detail, the mass flux rate increases from knot A6 to A3 in the HH34 jet in both the velocity components, probably due to a low estimation of the extinction in knot A6, then it decreases in knot A1. Finally, in HH46-47 the mass flux rate decreases from the inner to the more distant knots in both the high and low velocity components.

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